ISS Payloads Office
Cold Stowage Overview

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Cold Stowage

- Cold Stowage Fleet
  - Mixed fleet of active and passive systems to maximize mission flexibility and redundancy.
  - Temperature range available for Payloads is +48^{o}C to -160^{o}C.
  - All systems are compatible with Shuttle and ISS, some systems are compatible with Progress, and some systems are anticipated to be compatible with future vehicles such as ATV, HTV, CRS, and Cargo CEV.

NASA managed Cold Stowage Resources

Active

- **Minus Eighty Laboratory Freezer for ISS (MELFI)**
- **General Laboratory ACtive ISS Experiment Refrigerator (GLACIER)**
- **Microgravity Experiment Research Locker/INcubator (MERLIN)**

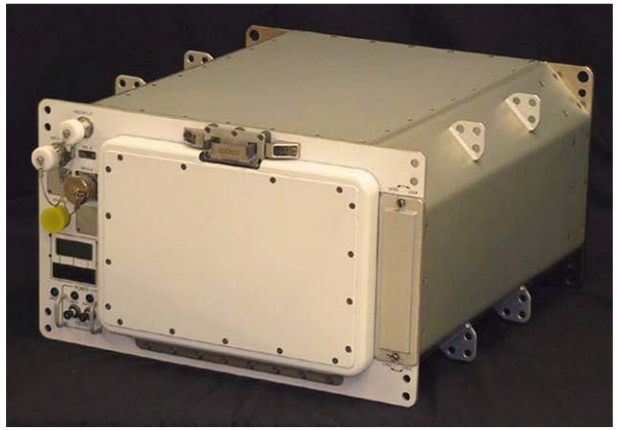
Passive

- **Cold Stowage Insulated Sample Bag (Double Coldbag)**
- **Icepac and Ice Brick Assemblies**

Active Freezers/Refrigerators

GLACIER
(double MDL)

MERLIN
(Single MDL)
Owned and presented by UAB

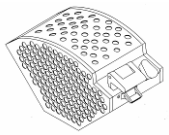


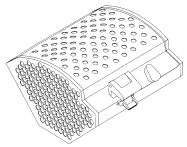
MELFI

MELFI Rack

MELFI – On-orbit cooling and low temperature science storage facility.

- MELFI complement consists of three Flight Units, one Training Unit, one Laboratory Ground Model, and one Engineering Unit.
  - First MELFI was launched on ULF-1.1 and is operating in the US Lab. MELFI was moved to the JEM in September 2008.
  - MELFI FU#2 is being launched on 17A (August 2009)
  - FU#3 is planned for launch on 19A (March 2010).
  - Ground units are all located at JSC.
- MELFI has four identical dewars each of which can be controlled independently at certain set points (as long as Dewar 1 is at -95^{o}C). The three set points for dewar temperatures are -95^{o}C, -35^{o}C, and +2^{o}C. Can hold 175 liters.
  - Dewars are divided longitudinally into four quadrants, each of which holds a long tray. Trays contain ¼ and ½ box modules which hold individual science sample





- MELFI is continuously powered on-orbit when supporting science and can maintain temperature below -68^{o}C with a power off duration of 8 hours.

GLACIER

GLACIER – Serves as an on-orbit low temperature science storage facility as well as cold stowage transportation to and from orbit.

- GLACIER complement consists of six Flight Units and one Engineering unit. Active ascent/descent in Shuttle Middeck, CRS and Cargo CEV. Passive ascent in ATV, HTV, and Shuttle MPLM possible (not yet certified for HTV or ATV).
- GLACIER supports a selectable temperature range of +4°C to -160°C
  - Middeck (36 cfm) or EXPRESS (30 cfm) air cooling mode: -95°C
  - EXPRESS water cooling mode (50 lbs/hr): -160°C
  - Maximum cooling rate 1°C/min to -160°C (GLACIER)
- GLACIER can accommodate a payload as large as 23.1 cm x 16.6 cm x 7.4 cm. (2.84 liters)
  - This is the internal dimension of a GLACIER tray
  - There are four GLACIER trays (effective total volume of all trays is 11.35 liters)
- GLACIER supports 18.1 lbs/8.2 kg (without Middeck waiver) of experiment samples
- GLACIER is a double Middeck locker equivalent in size.
- GLACIER vacuum insulated Cold Volume can maintain samples below -68°C for a maximum of 20 hrs without power, if operating at -160°C and is 75% full.

GLACIER cont.

- Active Glacier - Shuttle Ascent (utilizes Middeck AAA interface via VPMP)
  - Launched at cold temperatures with samples installed prior to turn over
  - Late installation at pad
  - Requires power during transport to pad (supplied by ground battery unit)

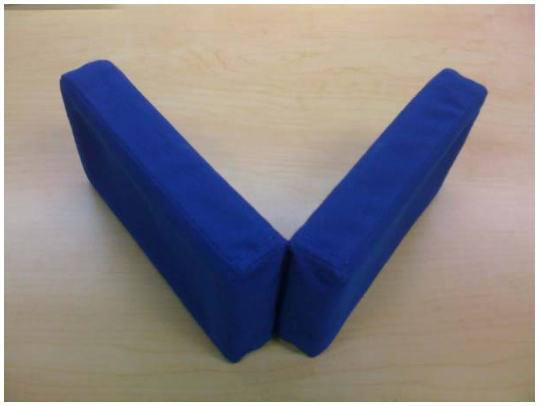
- Active Glacier - Shuttle descent (utilizes Middeck AAA interface via VPMP)
  - Early destow (science specific – typically R+6 hours for Middeck operations)
  - Requires power during transport from landing strip to the lab (supplied by ground battery unit)
  - De-integration in off-line laboratory

- 2 GLACIERs were flown on ULF-2. Glacier is planned to be flown as a sortie on every mission beginning with STS 128 (17A). Prior to shuttle retirement, at least 1 Glacier will reside on ISS in an Express Rack.
- Glacier will also be certified for alternate vehicles, and is planned to be used in CRS and CEV.

Passive Cold Stowage Resources

Double Coldbag

Icepac assemblies



Ice Brick Assembly

Coldbag

Coldbag – Passive low temperature science storage resource for transportation to/from orbit.

- Coldbag complement consists of 12 Double Coldbags.
- Icepacs/Ice Bricks provide cold conditioning for Coldbag contents.
- Temperature hold time depends on Icepac type & quantity, sample requirements, and environment. (For return - minimum 5.3 to 6 days).

- Double Coldbag
  - One Middeck locker insert in size and weighs 8.2 kg
  - Supports samples up to 7.9 cm x 18 cm x 26.6 cm in size.
  - Supports 4.6 kg of contents and has a usable cold volume of approximately 3.8 liters when using 9 Icepac assemblies.
  - Max mass with Icepacs and samples – 24.4 kg.
  - Compatible with Shuttle Middeck, MPLM, ISS, Progress, and loaded tested for ATV, HTV and future vehicles.

- Coldbag - Shuttle Ascent
  - Coldbags can be stowed in the Middeck, Spacehab, or MPLM. It can be stowed in a locker or soft stowed. If soft stowed, heavy items must not be stowed above the Coldbag.
  - Late loaded at the Pad if containing cold samples
  - Samples and Icepacs installed prior to turnover
- Coldbag - Shuttle Descent
  - Early destow if returning cold samples
  - De-integration in off-line laboratory

Icepac

Icepac – Solid-liquid phase change material in a hard plastic capsule compatible with the cold stowage systems

- Icepacs provide cold conditioning for Coldbag and are designed to be refreezable on-orbit in active freezers (e.g. MELFI, GLACIER, MERLIN).
- Icepacs are available in specific melting temperatures: +4°C, 0°C, -16°C, -21°C, and -32°C.
  - Temperature hold time depends on Icepac type & quantity, sample requirements, and environment (typically 4 – 10 days).
  - Each type is a different color.
- Icepacs are incorporated into a belt assembly of eight identical Icepac types.
- Each Icepac assembly weighs between 0.97 - 1.29 kgs. and has a volume of 1.9 liters.
- Engineering/EC2 will determine the Icepac configuration based on mission requirements.

Ice Brick

Same concept and Phase Change Material as Icepac, the only change is the shape (cylinder vs. brick) and the addition of the Nomex belt.

- Designed to eliminate fit issues within MELFI ¼ box modules, and to make the Coldbag packing easier for the crew.
- Ice Bricks currently available in specific melting temperatures: +4°C, -26°C, and -32°C.
  - Temperature hold time depends on Ice Brick type & quantity, sample requirements, and environment (performance expected to be same or better than Icepac).
  - Each type is a different color.
  - ~14 belts required per bag
- Ice Bricks are incorporated into a belt assembly of 2 identical Ice Brick types.
- Each Ice Brick assembly weighs between .7 - .8 kgs. and has a volume of .5 liters.
- Engineering/EC2 will determine the Icepac configuration based on mission requirements.

Cold Stowage Team

- Cold Stowage (CS) Responsibilities
  - Provide Engineering oversight for hardware development and operations.
  - Deliver CS hardware to KSC for flight and performs off-line operations.
  - Support MELFI, Glacier, Merlin, and other cold stowage operations on-orbit.
  - Integrated Cold Stowage Performance analysis
  - Compatibility Analysis for Safety
- Cold Stowage Partners
  - NASA JSC
    - OZ Payloads Office
    - EC Thermal System and Engineering Support
  - Contractors
    - Jacobs Engineering (Engineering Science Contract)
    - University of Alabama Center for Biophysical Science and Engineering

Cold Stowage Services Provided to Payloads

- On-orbit operation of MELFI and GLACIER systems, and for payloads contained in those systems, in full coordination with MSFC POIC.
- Cold sample launch is supported at KSC.
- Cold sample return is supported at KSC, DFRC, and WSSH.
- Testing in Cold Stowage Laboratory
  - Ability to conduct thermal cycle testing (i.e. acceptance thermal cycle, cryo-cycle, etc.)
  - Conduct thermal performance tests (e.g. determine how long will samples will stay cold in Double Coldbag or MELFI during a power off)
  - End-to-end/Science Verification testing duplicating planned on-orbit scenarios with CS Fleet
  - Load testing of samples in range +93ºC to -150ºC
  - Available equipment
    - Fully functional Engineering Units of all systems including MELFI (also MELFI Laboratory Ground Model)
    - Harris Freezer: 0ºC to -40ºC
    - Sanyo Freezer: -100ºC to -150ºC
    - Engel Freezer (portable): +4ºC to -24ºC
    - Environmental Freezer & Incubator +93ºC to -75°C
    - Cryogenic dewar: -196ºC
    - Coldbag
    - Icepacs and Ice Brick
- Crew Training
  - Cold Skills Training
  - Coldbag/Icepac Packing Training
- Engineering Evaluations
  - Full function Engineering Units of all systems including MELFI
  - Conduct fit checks and develop packing plans for Payloads utilizing Cold Stowage Fleet.